2011

Perception of Exuberant Exponence in Batsbi

Alice Carmichael Harris
acharris@linguist.umass.edu

Arthur G. Samuel

PERCEPTION OF EXUBERANT EXPONENCE IN BATSBI:
FUNCTIONAL OR INCIDENTAL?

ALICE C. HARRIS

University of Massachusetts Amherst and *Stony Brook University*

ARTHUR G. SAMUEL

Basque Center on Cognition, Brain and Language; *Ikerbasque, Basque Foundation for Science*; and *Stony Brook University*

Batsbi has multiple exponence (redundant marking) in gender-number agreement, and in this article we explore the question of whether marking of this kind is functional. In a series of three experiments, we compare verbs that have no agreement marker with ones that have a single marker, and we compare verbs with one agreement marker with ones that have two. We find that word recognition is slower with agreement than without it; and words with two agreement markers are recognized more slowly and with more errors relative to verbs with a single marker. For grammaticality judgments, subjects were generally slower to respond when the verb carried more markers. For verbs with no marker versus verbs with one marker, this extra cognitive effort yielded improved accuracy; however, this advantage did not extend to multiple exponence, as the extra processing time did not produce much improvement in accuracy. In cued recall, the presence of one marker conferred a clear advantage in accuracy, but the presence of two agreement markers actually resulted in decreased accuracy. Overall, multiple exponence was found not to confer a functional advantage in these experiments.*

Keywords: multiple exponence, extended exponence, processing, Batsbi, endangered language, experimental

1. THE ISSUES. Some linguistic phenomena are common, not only in familiar languages of Europe, but also in languages around the world; other phenomena are truly rare. Linguists have suggested a variety of explanations for the rarity of certain features. Greenberg (1978) asserted that a phenomenon is rare because it is introduced by a linguistic change that seldom occurs. Whether or not this is true, it does not help much, since it leaves us needing to explain why some changes occur only infrequently. Bowerman (1985) suggested that phenomena might be rare because they are difficult for children to acquire. Unfortunately, little is known about the acquisition of most truly rare phenomena. Hawkins and Cutler (1988) have suggested that one relatively infrequent phenomenon, prefixing, is less frequent because it is more difficult to process than the competing suffixing. Many linguists believe that certain phenomena are rare because they are discouraged by universal grammar (UG; see Newmeyer 2005 and Harris 2010 for some discussion). If that is correct, we need to know HOW UG discourages these phenomena. Is it by making them difficult to learn or process?

None of these suggestions really addresses the question of why, if certain phenomena are difficult to acquire or difficult to process or discouraged by UG, some languages would nevertheless have those phenomena as parts of their grammars. Further, none of these approaches explains why some rare phenomena are known to last a very long time

* The research reported here was supported in part by grant number BCS 0745522 from the National Science Foundation and by grant numbers R01-51663 and RO1-059787 from the National Institutes of Health; we are grateful for this support. We would also like to thank Andrei Antonenko, Poppy Slocum, Mariam Tsiskarishvili, and Donna Kat, who provided essential help with this project. We could not have done the experiments without the help of Naira Tsiskarishvili, our Batsbi consultant. We are also grateful to Harald Baayen for doing the statistical analyses. The results of this research have been presented at Stony Brook University, at the Endangered Languages Infrastructure and Information Workshop, and at a Workshop on Complexity held at the Max Planck Institute for Psycholinguistics; we are grateful to all three audiences for their comments and discussion.

(see Harris 2008a,b). If these rare phenomena are difficult to learn or process or are discouraged by UG, would it not be in the best interests of languages to rid themselves of these phenomena as quickly as possible?

In this article we examine multiple exponence (redundant marking) in Batsbi, an endangered language of the Nakh-Daghestanian family that is now spoken by perhaps only two or three hundred individuals. An exponent is a marker of some feature or bundle of features; in our example, the exponents at issue mark gender and number. In its exuberant variant (Harris 2009, and below), where three or more exponents may occur in a word, multiple exponence is surely rare. It appears that it is less rare but still uncommon for a language to have two exponents within a single word. Because exuberant exponence is rare and some of the languages that embody it are severely endangered, we feel that there is an urgent need to study how speakers understand this phenomenon, and we conducted experiments with a language that has exuberant exponence to determine this. In order to have appropriately matched stimuli, however, it was necessary to limit our investigation to two, one, and zero occurrences of the exponents at issue.

The central question that shapes this research is whether multiple exponence provides any advantage in the processing of language, or on the contrary, whether it is a liability in processing. If ease of processing determines how common a phenomenon is among languages of the world, as has been suggested, we would expect multiple exponence to be difficult to process (since it is not common) and exuberant exponence to be very difficult to process (since it is truly rare). If, by contrast, ease of processing is unrelated to how common a phenomenon is, we might find that multiple exponence bestows a benefit in processing because it potentially provides the listener with multiple opportunities to take in the information marked by the exponents.

In this context we examined word recognition, grammaticality judgments, and memory for words varying in the presence of multiple exponence. We begin by introducing multiple exponence in Batsbi. In subsequent sections, we describe and discuss the results of auditory lexical-decision, grammaticality-judgment, and memory tasks that we asked subjects to perform. We end with a discussion of the significance of our findings. Although there are a few hints to the contrary, overall we find that multiple exponence bestows no advantage in processing, and in fact tends to be disadvantageous.

We note at the outset that experimental work on languages with very small populations faces many obstacles. For example, there is no database of Batsbi texts from which to determine word frequency. We were unable to maintain the conditions one would find in a laboratory doing work on language processing, and instead we had to go to our subjects' homes, where dogs and children sometimes ran in and out, and where neighbors came in expecting to be greeted by the subject engrossed in the experiment. Many small and endangered languages have phenomena not found in the most populous languages, in which processing is usually studied. We believe that it is important to try to understand how these phenomena are processed while the languages that host them are still here. We believe that it is essential to conduct this research even with the obstacles described above, and others.

2. Description of batsbi. Batsbi (also known as Bats or Tsova-Tush) is a severely endangered language of the Nakh branch of the Nakh-Dagestanian language family. Batsbi is spoken in the village of Zemo Alvani (Upper Alvani) in the Kakheti region of the Republic of Georgia. All Batsbi people speak Georgian, and many also speak Russian; none of these three languages is related to the others. For several generations Batsbi people have attended schools taught in Georgian.

Nouns in Batsbi belong to one of eight genders, as illustrated in Table 1; however, three of the genders—4, 7, and 8—each contain only a few nouns. Gender 1 contains all and only nouns referring to male humans, while gender 2 contains all and only nouns referring to female humans. Nouns such as 'friend' or 'neighbor' can be treated as members of either gender, according to context. The remaining genders are not predictable. These eight genders and two numbers (singular and plural) are expressed using only four distinct markers, as shown in the table. The markers undergo very little phonological change and reliably retain these forms whether they are initial, medial, or final in a word. These markers—*v-*, *b-*, *y-*, and *d-*—are traditionally referred to as CLASS MARKERS and are glossed here with the abbreviation CM.

GENDER	SINGULAR	PLURAL	EXAMPLE	
1	v	b	voħ	'son'
2	y	d	ag	'grandmother'
3	y	y	q'ar	'rain'
4	b	b	borag	'knit shoe'
5	d	d	bader	'child'
6	b	d	matx	'sun'
7	b	y	bʕark'	'eye'
8	d	y	lark'	'ear'

TABLE 1. Grammatical genders in Batsbi (from Harris 2009).

CMs may occur on verbs, adjectives, and on a few nouns, adverbs, and numerals; the focus here is the CM on verbs. For simple (noncompounded) verbs, there are two lexically determined positions in which a CM may occur, and each position may be filled or may be empty, independently of the other position. Here these positions are referred to as preradical and postradical, since one precedes and the other follows the root. Whether a CM position is filled or empty is strictly determined by the verbal lexeme. That is, a given verb must have a particular position filled or empty, with no variation permitted. All logically possible permutations occur, as illustrated in Table 2. In the table, the CMs are separated off with hyphens. In the word ***d***-*ag*-***d***-*alar* 'show oneself, be seen', the root is *-ag-*, and the suffix *-al* makes it intransitive. As in the other entries, *-ar* is the morpheme that forms the masdar (verbal noun), and *-d* is the default CM. In the entry ***d***-*aɬar* 'give; appear', the root is *-aɬ-*. The entry *tag-d-alar* 'be done, be made' includes the root *tag-* and the suffix *-al*, which is the intransitivizer. In the last entry, *ol:ar* 'thread; put on; ladle out', the root is *ol:-*.

	WITH POSTRADICAL CM		WITHOUT POSTRADICAL CM	
WITH PRERADICAL CM	**d**-ag-**d**-alar	'show oneself, be seen'	**d**-aɬar	'give; appear'
WITHOUT PRERADICAL CM	tag-**d**-alar	'be done, be made'	ol:ar	'thread (e.g. needle); put on (e.g. clothing); ladle out'

TABLE 2. Distribution of CMs in Batsbi.

Other combinations, such as **ag*-***d***-*alar*, ****d***-*agalar*, **agalar*, are either ungrammatical or a form of a different verbal lexeme, with a different meaning. As an example of the latter, *aɬar* (compare ***d***-*aɬar* in the upper right cell) is grammatical, but it means 'say' and thus cannot be considered a form of ***d***-*aɬar* 'give; appear'. We were able to identify some nineteen pairs of this sort; a half dozen examples are shown in Table 3.

d-ak'ar	'burn (intr. active)'	ak'ar	'burn (intr. stative)'
d-at'ar	'run away, flee; split'	at'ar	'become quiet'
d-et:ar	'fling; milk (e.g. sheep); pour'	et:ar	'stand, stay'
d-ešar	'intend, promise'	ešar	'lack, be missing (intr.)'
d-ot'ar	'go, go over'	ot'ar	'spread'
d-oc'ar	'tie; enclose'	oc'ar	'pull, move; weigh'

TABLE 3. Minimal pairs with and without a CM.

As one can see, in some instances the verbs seem to be related semantically, but not in a systematic way.

The CM *d-* is the default marker in the sense that speakers use this when they do not know the identity of the noun with which the verb agrees. For example, a speaker asking 'Who is knocking?' or 'Who do you see?' uses the default CM *d-*, since s/he does not know whether the 'who' is male or female. Gender 5, with *d-* as the marker of both singular and plural, is also the largest gender and the gender into which many borrowed nouns are placed. Finally, *d-* is the CM used in citation forms in the dictionary written by native speakers of Batsbi (Kadagiʒe and Kadagiʒe (1984)) and by other linguists. It is also used in citing forms in this article.

Whether a given lexeme occurs with a CM in a particular position is partially predictable. Preradical CMs can occur only if the root begins with a vowel or ʕ; as one can see from Table 3, however, a CM cannot necessarily be predicted when a root does begin with one of these sounds. The suffix *-al* and the suffix *-i* are always immediately preceded by a CM (even if *-i* is omitted for phonological reasons). The occurrence of *-al* and *-i* is itself not predictable, however. The suffix *-al* forms intransitives from transitives; not all intransitives, however, bear this suffix. ***D****-oc'-****d****-alar* 'be tied; be enclosed' is an intransitive derived from the transitive verb ***d****-oc'ar* 'tie; enclose' by the addition of the *-al* suffix, and ***d****-* (or another CM) is always required with this suffix. ***D****-ot'ar* 'go' is an example of an intransitive verb that lacks *-al*. The suffix *-i* derives transitives, but not all transitives bear this suffix. This suffix deletes before other vowels except *e*; when deletion occurs, it is the CM alone that indicates the presence of the transitive morph. Transitive *et'-****d****-ar* 'rip, split, tear' is derived from the intransitive *et'ar* 'rip, split, tear' by the addition of *-i*, which in turn requires a preceding CM. Since the suffixes *-al* and *-i* are only partially predictable, the presence of the CMs they require is also only partially predictable.

In Batsbi, CMs are controlled by subjects of intransitive verbs, as illustrated in 1, and by direct objects of transitive verbs, as illustrated in 2.[1]

(1) e yoħ bacb-a-n=i y-a?
this girl(y/d).ABS Batsbi-OBL-GEN=Q CM-be
'Is this girl one of the Batsbis'?'

(2) vaħ-o-v yoħ y-ik'-e^{n} sk'ol-i
boy(v/b)-TV-ERG girl(y/d).ABS CM-take-AOR school-DIR
'The boy took the girl to school.'

[1] The following abbreviations are used in glossing: ABS: absolutive case, AOR: aorist tense, CM: class (gender-number) marker, DIR: directional case, ERG: ergative case, GEN: genitive, OBL: oblique, Q: question, TV: thematic vowel. Class markers are listed in parentheses following a noun gloss, with the singular marker before a slash, and the plural after. Throughout, /y/ is a glide; other symbols have their IPA values. Examples not otherwise attributed are from Harris's fieldwork. The original data on which this article is based are provided on Alice Harris's website, http://scholarworks.umass.edu/linguist_faculty_pubs/132/.

In 1, 'this girl', the subject, is in gender-class 2, which takes the marker *y-* in the singular and *d-* in the plural, as shown in the parentheses in the gloss line. In 2, also, 'girl' requires the CM *y-* in the singular. Thus, the CM can be controlled by the subject or the object, depending on the transitivity of the sentence. Subjects of transitive verbs occur in the ergative case and do not condition CMs, as one can see in 2 from the fact that there is no *v-* indicating agreement with 'boy', which takes *v-* in the singular.

In order to learn how speakers process verbs of three sorts—verbs that lack gender agreement altogether, verbs that govern one gender agreement marker, and verbs that govern two gender markers—we designed three experiments that compare these three conditions.

3. Experiment 1: auditory lexical-decision task on verbs of various types. The first experiment involves a standard lexical-decision task in which listeners hear real words and pseudowords and must decide for each one whether it is a real word. This task has been very widely used as a measure of the speed and accuracy of word recognition. In the current study, the goal is to determine whether speakers recognize verbs of the three classes identified above differentially. That is, the question addressed is whether the presence and number of CMs will affect the cognitive processing of these words.

Although it was long assumed that the addition of a morph results in an increase in response time, suggesting that morphological complexity increases the cognitive load, recent work has shown that determiners of response time are much more nuanced (for example, Bertram et al. 1999, Bertram et al. 2000, Burani & Thornton 2003, Kuperman et al. 2010). Response time seems to be sensitive to, among other things, differences between derivational and inflectional morphology, the productivity of an affix, and both root and surface (whole word) frequencies. It is not clear how the presence of multiple marking would interact with these characteristics, and response time may depend in part on how affixes are specified in the mental lexicon. In a verbal lexeme with two CMs, is each affix fully specified for gender and number, or is one underspecified? If recognition times for words with two CMs do not differ significantly from response times for words with one CM, this might suggest that one CM is underspecified in the mental lexicon. A different but related possibility is that it is not the formal morph that is processed, but rather the features introduced by the morph. Since the second CM introduces no additional features, there would be no additional delay if it is the number of semantic features, rather than the number of morphs per se, that matters.

To examine these questions, we constructed two stimulus sets. In one set, there were pairs of words that differed in the presence (1 CM) versus absence (0 CM) of markers. In the second stimulus set, the contrast was between words with a single CM (1 CM) and those with two (2 CMs). The first set allows us to test whether processing is slower and/or less accurate for words with CMs, and the second set provides a test of whether multiple marking imposes additional processing costs.

3.1. Materials.

Verbs with 0 versus 1 CM. The ideal stimuli to use to examine whether class markers have cognitive processing costs would be pairs of words that are identical except for the presence versus absence of a class marker. There are actually two different ways that this ideal could be implemented, and we chose to construct two sets of stimuli, with each set using one of the two approaches. Verbs in set A were minimal pairs where one member has a CM in word-initial position, and the second member lacks the CM; the roots are identical. An example is *d-aɬar* 'give; appear' and *aɬar* 'say'. This pair meets the goal of differing only in the presence versus absence of one CM.

The stimuli in this and the other stimulus sets were approximately matched for lexeme frequency. Since Batsbi is an understudied language, there are no large databases comparable to the Kučera and Francis (1967) corpus, the British National Corpus, or the CELEX database. It has been shown, however, that speakers are able to provide roughly accurate evaluations of word frequency (K. Forster, p.c., October 2009), and native-speaker estimates of frequency have been used in other experiments in languages that have (or had) no large corpus, such as Modern Hebrew (Feldman et al. 1995). To get a general index of lexical (not form) frequency, we asked our consultant to evaluate how common each word was on a scale of 1 to 5. Some words have more than one meaning, and some are even different entries in the dictionary. This is taken into account in the frequency rating, a composite rating for all meanings. These are presented by condition in Appendices A–C.

Nineteen minimal pairs were selected.[2] As shown in Appendix A, for each real Batsbi word we created a nonword by replacing one or more phonetic segments; these were the nonword items used in the lexical-decision task. Both real words and nonwords end in *-ar*, the morph that forms the masdar (verbal noun), which is used as the citation form in Batsbi. There are no monomorphemic verbs in Batsbi, but in every instance a word with *N* morphemes is paired with a word with *N* plus a CM.

Each 1 CM verb in set A differed from its 0 CM counterpart by the addition of the initial CM. We constructed another group of stimuli (set B) that was also made up of pairs that differed in the presence versus absence of a CM; verbs in set B were also pairs in which one member has a single CM in word-initial position and the other member does not. In this set, however, the 0 CM member begins with a consonant that cannot occur as a CM. An example of this type of pair is *d-agar* 'see, catch sight of' and *tagar* 'suit someone (e.g. clothing)'. With this matching method, each member of the pair contains the same number of consonants and the same number of vowels (in this example, each contains three consonants and two vowels). There were twenty-four pairs in set B. As with set A, each member has a matching pseudoword. Stimuli from set B are listed in Appendix B.

For both set A and set B there was a close match in the average estimated word frequency for the words having 1 CM and those having 0 CM. For set A, the words with a CM had an average frequency rating of 4.4 on the five-point scale used by our native Batsbi consultant, while those without a CM had an average frequency rating of 4.3. For set B, the corresponding values were 4.0 (1 CM) and 3.9 (0 CM). Stimulus length was also approximately equal for the 1 CM (957 ms) and 0 CM (973 ms) words in set B, reflecting their matched number of consonants and vowels; the average durations did not differ, $t(23) = 0.26$, n.s. As one would expect, for set A, in which the 1 CM (988 ms) words were one consonant longer (the CM itself) than those with 0 CM (950 ms), there was a small average difference in duration. Nonetheless, the two conditions did not reliably differ in duration, $t(18) = -0.87$, n.s.

Verbs with 1 versus 2 CMs. To test the effect of multiple marking, we selected twenty-eight pairs of words that differed in the number of markers—1 CM versus 2 CMs. The pairs each contain one member that has two CMs—one in word-initial posi-

[2] Through researcher error, only seventeen of the nineteen pairs in set A actually contrast 1 CM with 0 CM; because of a mistake, two pairs contrast 2 CMs with 1 CM.

tion and the second in postradical position; the second member of each pair begins with a consonant not occurring as a CM. Members of a pair were designed to be quite close in phonological complexity; many pairs are phonologically identical except for the first consonant. Five pairs are intransitive, and both members end in the morphology -***d***-*al-ar*. The rest, twenty-three pairs, are transitive, and both members end in the morphology -***d***-*ar*. Each word was matched by a pseudoword, for a total of 112 test items. These stimuli are listed in Appendix C.

The paired stimuli were closely matched in both average estimated word frequency and in duration. The 1 CM words had an average frequency rating of 4.0, which was also the average for the 2 CM words. The average duration of the 1 CM words was 891 ms, quite close to the average of 887 ms for the 2 CM words. As with set B, this reflects the close matching of the consonant and vowel structure within each pair of words. And as with the other stimulus sets, there was no statistical difference in duration between the two conditions, $t(27) = 0.10$, n.s.

To the words and pseudowords described above, we added fifty nonword distractors. These pseudowords began with *d*-, to prevent subjects from thinking that any item that began with this sound would always be a real word. These items are listed in Appendix D. Thus the total number of items tested was 334. All pseudowords were constructed so that every consonant cluster occurs in real words.

All stimuli were in the masdar citation form, declinable verbal nouns marked by the suffix -*ar*. All agreeing forms used the default CM *d*-. Since the perfective/imperfective stem alternation (described in Appendix G) may be considered a hidden morph in verbs that have this characteristic, the pairs of verbal lexemes in each set are approximately matched for this quality. (One may think of the possibly delayed response time in answering the question of whether *feet* is a word; *feet* contains plural marking, which might also be considered a hidden morph.) In Appendices A–C, stems with perfective/imperfective alternation are marked ‘yes’ in the column labeled ‘ablaut’, and the numbers of ‘yes’ indices are tallied at the bottom. In those stems that have number suppletion, that is an additional possible hidden morph; therefore, the lexemes in the two groups in each set are approximately matched for this as well. In the appendices, lexemes with this characteristic are marked ‘yes’ in the column labeled ‘number suppletion’, and the numbers are tallied at the bottom.

All words and pseudowords were spoken by a native speaker of Batsbi residing in New York City and were recorded using a Roland Edirol R-09 digital recorder. Stimuli were transferred to a computer, and the clearest presentation was selected from three or more repetitions. GoldWave software was used to reduce background noise and to normalize stimulus amplitude. The final stimuli were transferred to a laptop PC that was carried to the Republic of Georgia.

3.2. METHOD. We estimate that there are only about 100 fluent speakers of Batsbi resident in Zemo Alvani, the village where the language is spoken. Nonetheless, we were able to recruit forty native speakers. Of these, twenty-two were female; the age range of all subjects was 38–84, with a mean age of sixty-seven. Participants were offered a modest payment, but all declined.

Subjects were tested in their own homes or in the home of a neighbor. Stimuli were presented using headphones, and subjects responded to each item by pushing one of two labeled keys on the laptop keyboard. Presentation order of the 334 stimuli was randomized for each subject. Experimenters spoke to subjects exclusively in Georgian, an unrelated language, in which all Batsbis are schooled.

While it was not feasible to test hearing, potential subjects who could not comfortably hear the stimuli were not permitted to complete the experiments. All subjects were self-reported native speakers of Batsbi.

Each subject was instructed in how to respond by pressing designated keys on the computer. Subjects were provided with an example of a real word and a pseudoword; if they wanted more instruction, a second pair of examples was available, but few took this option. The overall duration of experiment 1 was about ten minutes, with no breaks.

3.3. Results and discussion. As would be expected for a relatively elderly population unfamiliar with experimental procedures, a number of the participants did not consistently make the desired judgment of 'real word' versus 'not real word'. Ten participants responded to almost all of the items by pushing the 'word' button, producing pseudoword error rates well over 60%, and one participant appeared to have responded randomly. The data from these participants were not included in the analyses, leaving twenty-nine participants to be included in the statistical analyses.

In the current experiment, and in those that follow, statistical significance of any difference in accuracy across the conditions (e.g. number of class markers) of a task was assessed using a generalized linear mixed-effects model. In these models, a logistic link function and binomial variance were fit to the data, with both participants and items treated as random factors. Analyses of reaction times were based on mixed-effects regression models, with participants and items again treated as random factors. In the reaction-time analyses, as is typically done, we only used trials on which a correct response was made.

Does marking a verb add to its processing difficulty? We first examined the results from the two sets of stimuli that contrasted verbs with one CM versus matched items with no CM. Recall that we matched items in two ways: in set A, the 1 CM member of a pair had an initial CM that was not present in its matched 0 CM mate (e.g. *dat'ar* 'run away; split' versus *at'ar* 'become quiet'); in set B, the two members of a pair had the same number of vowels and consonants, and only differed in the identity of one phonetic segment, with that segment either serving as a CM (e.g. in *dagar* 'see, catch sight of') or not (e.g. in *tagar* 'suit someone (e.g. clothing)'). For the 0 CM and the 1 CM members of each stimulus set, we calculated the error rates and average reaction times for each of the twenty-nine subjects.

Figure 1 presents the average error rates and reaction times, broken down by the two methods of matching pairs of words. A preliminary statistical analysis indicated that there were no significant differences between the two methods for both accuracy and response times, and as such, we report the results collapsed across the two stimulus sets. In these analyses, we included two fixed effects in the models: the primary factor of interest—number of class markers (0 versus 1, and 1 versus 2)—and the frequency estimates that our consultant had provided for each word. In the large existing literature on Indo-European languages, higher-frequency words typically produce better performance (lower error rates and/or lower response times).

The left side of Fig. 1 shows the average error rates for the 0 CM and the 1 CM words, constructed using both methods. As the figure shows, there was an error rate of about 13%, and it was essentially the same for words with no CM (13.7%) as for words with 1 CM (13.3%), $z = -0.3977$, n.s. The comparable accuracy for these two conditions allows us to consider the reaction times without any concerns about a speed–accuracy trade-off.

Word frequency produced a reliable effect, with more frequent words producing fewer errors, $z = 2.7811$, $p < 0.01$. There was an intriguing but only marginally signifi-

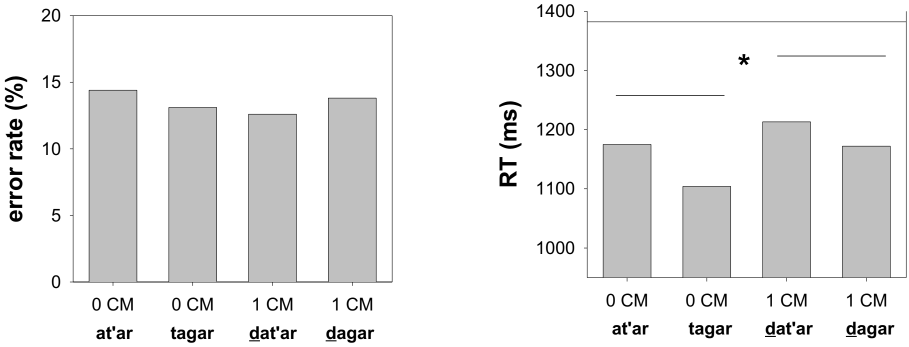

FIGURE 1. Error rates (left panel) and reaction times (right panel) for the lexical-decision task of experiment 1, for the comparison of words with 0 CM versus words with 1 CM.

cant ($p = 0.07$) interaction between the two factors, reflecting a different effect of frequency for words with 0 versus 1 CM. For the 1 CM items the typical pattern was found, with accuracy correlating with frequency. In contrast, for the 0 CM items accuracy was generally high (error rates between 5% and 10%) and independent of word frequency.

The reaction-time results shown on the right side of Fig. 1 are clear: it took the subjects longer to recognize Batsbi words with 1 CM than words without a CM, $t = 2.106$. (Note: here and throughout, a t-value greater than 2.0 reflects a statistically reliable difference. Since the number of degrees of freedom for mixed models is not known, we use the upper bound for the degrees of freedom (N – # of parameters), which for our data is so large that the t-distribution converges to the normal. To be conservative, we require $|t| > 2$ for significance, rather than $|t| > 1.96$.) A trend toward faster responses to more frequent words did not reach significance, $t = -1.386$.

The central result here is that it is more difficult (i.e. it takes longer) to recognize a word that includes a root and ending plus a CM than one that simply has a root and ending. This result is consistent with the view that morphological complexity brings with it a processing cost. Reasons for this are discussed below.

DOES MULTIPLE MARKING OF A VERB ADD TO ITS PROCESSING DIFFICULTY? Figure 2 presents the corresponding error and reaction-time results for a comparison of word recognition for stimuli that differ in whether they have a single CM or two. These results also show a cost for processing class markers: words with 2 CMs generated more errors (left panel) and slower responses (right panel) than words with a single CM. Average reaction time for 1 CM words was 1,174 ms, versus an average of 1,288 ms for 2 CM words, $t = 2.026$. Words with a single CM were correctly identified as words 88.5% of the time, whereas the accuracy for the 2 CM cases was only 80.4%, $z = -2.626$, $p < 0.01$. Word frequency also produced reliable effects on both reaction times ($t = -2.456$) and on accuracy ($z = 3.690$, $p < 0.001$); there was no interaction between frequency and number of class markers, for either reaction time or accuracy.

Experiment 1 shows that subjects encountered more difficulty in recognizing words when the words included class markers. Words with a single marker took longer to recognize than ones without any markers, and words with two markers were not recognized as accurately or as quickly as those with only one.

The literature shows that in visual lexical-decision tasks, many properties of words, roots, and affixes contribute to determining the processing method that will be used,

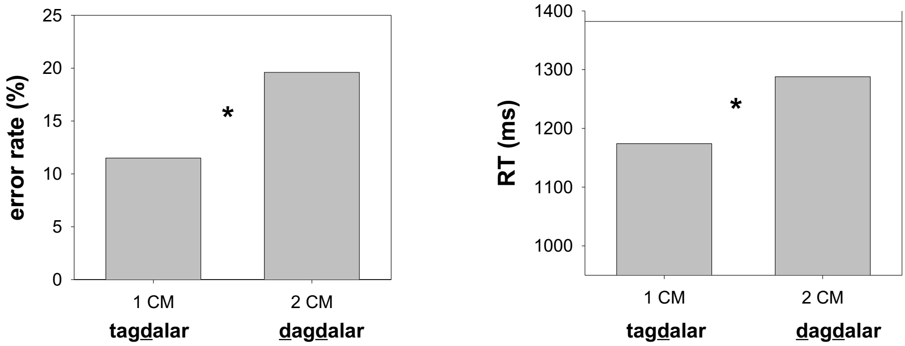

FIGURE 2. Error rates (left panel) and reaction times (right panel) for the lexical-decision task of experiment 1, for the comparison of words with 1 CM versus words with 2 CMs.

and thus the processing time (response latency). Laudanna and Burani (1995) suggest that the presence of an affix that is perceptually salient leads to morphological processing (parsing); this, in turn, is associated with longer response latencies. Laudanna and Burani define the perceptual salience of an affix as the likelihood of recognizing that affix as a unit that requires its own processing. CMs may be considered salient in this sense, since they occur in many lexemes.[3] This would explain the results summarized in Fig. 1. Batsbi -CM-*al* and -CM-*i* can also be considered salient for the same reason and because they occur in new words (borrowed from Georgian). Plag and Baayen (2009) show this effect for very high-frequency derivational affixes in visual lexical-decision tasks in English, but see Burani & Thornton 2003 for a null effect of such affixes (in Italian). These studies suggest that frequent affixes trigger morphological processing, rather than direct access, even for derivational morphology. Morphological processing, in turn, leads to longer processing times.[4]

If we assume that these effects can be generalized to auditory lexical decision and to other languages, the fact that CMs in Batsbi are highly productive leads to their forcing increased morphological processing, rather than direct access. The greater difficulty of this type of processing produces longer processing times in the case of a first CM and both longer processing times and a higher error rate in the case of a second CM. Our results are consistent with Plag and Baayen's (2009) finding that words with more productive affixes tend to have longer processing times than words with less productive

[3] Burani and Thornton (2003:160) suggest the term 'numerosity' for the measure of how many lexemes an affix occurs in, and they note that 'suffix numerosity is closely related to suffix productivity' and that numerosity of an affix aids in its recognition as a separate processing unit. CMs are highly numerous in this sense; out of 2,178 verbal lexemes in our database of Batsbi verbal lexemes, 1,622 (or 74.47%) have a CM somewhere in the stem. Thus, on the basis of the correlation observed by Burani and Thornton, we believe CMs are highly productive in Batsbi. In a highly endangered language, productivity can be difficult to determine directly.

[4] On the basis of visual lexical-decision tasks in Finnish, Järvikivi, Bertram, and Niemi (2006) argue that allomorphy makes an affix less salient and thus triggers full-form storage. However, the Finnish experiments do not consider allomorphy that is conditioned by phonology (e.g. *-ja* ~ *-jä* vowel harmony variation is conditioned by the vowels in the root), only allomorphy that is conditioned by morphology. The Batsbi morphemes closely associated with postradical CMs, namely *-al* and *-i*, do show some allomorphy, but it is phonologically conditioned.

affixes. Given the processing costs reflected in the longer processing times and higher error rates, the central question is whether listeners get any return on the investment of effort: Is it easier for a listener to recognize the agreement between a verb and a noun if the verb has a CM than if it does not? Similarly, is this grammatical match easier to determine with multiple CMs than with a single marker?

4. Experiment 2: grammaticality judgment. The second experiment involves simple grammaticality judgments. The goal was to determine whether the number of gender agreement markers affects how well the listener can determine grammaticality. That is, again, does the presence of one or more gender agreement markers affect response latency?

4.1. Materials. Each stimulus consisted of a verb and its subject or a verb and its object. The verbs were in the present tense, imperfect tense (past imperfective), or aorist tense (past perfective); these three are among the simplest and most frequently used tenses in the language. Each verb + subject and each verb + object formed a complete sentence. This is possible because in Batsbi, unemphatic subjects and objects are not necessarily represented by independent pronouns. For example, *čxindur d-opx^w^* 'puts on a sock, stocking', since it lacks any specific subject ('I', 'you', 'we', or 'y'all'), is interpreted as 'he, she, or they puts/put on a sock'. The verbs used were drawn from those used in experiment 1, described above.

In order to ensure naturalness, stimuli were drawn as much as possible from examples given in Kadagiʒe & Kadagiʒe 1984. In the paired examples, each verb was matched with two subjects or two objects of different genders (or occasionally different numbers). In most instances the second stimulus for a particular verb was created by substituting a noun from the same semantic category but of a different gender. For example, with the verb 'spread out', Kadagiʒe and Kadagiʒe give an example 'the sheep spread out'. Examples such as 'the water spread out' were avoided for semantic reasons. 'Horses spread out' did not serve our purpose, because 'horse' is of the same gender as 'sheep', and there would thus be no contrast in the form of the verb. 'Cows spread out' served our purpose, since this noun is of a different gender. In a few instances we asked the consultant for a second illustration. For example, we got 'sets leaf' from Kadagiʒe and Kadagiʒe; but we did not know what else might be used with this verb, so our consultant suggested an example.

In recording the stimuli, the consultant was presented with the written equivalent in Georgian, and she also saw the Batsbi written out in IPA beside it. She read each Batsbi sentence (verb + subject or verb + object) very slowly. For this reason there was minimal gestural overlap (coarticulation), and we could easily cut and splice an inappropriate subject or object onto a verb. For example, we were able to cut *xalat* cleanly from *xalat y-opx^w^* 'puts on a housedress' and splice it onto *d-opx^w^*, resulting in the example **xalat d-opx^w^*, which is ungrammatical because it has an inappropriate agreement marker.

In Batsbi there are five large, productive or semi-productive genders and three very small genders containing respectively fifteen, five, and three nouns. In our examples we entirely avoided using nouns of these three small genders.

We constructed sixteen pairs of two-word expressions to compare verbs that have one CM with verbs that have none. Two of the pairs were drawn from experiment 1's set A, and thirteen pairs were taken from set B; one pair was made from one item from set B and one from the items that had been used to compare two versus one CMs in experiment 1. The stimuli for comparing verbs that have two CMs with verbs that have one CM were eighteen of the pairs that had been used for that purpose in experiment 1.

Thus, there were thirty-four verbs, each in two forms (except those with no CM, which have only one form), arranged in pairs.

For each verb, two examples with subjects or objects were recorded; for those with at least one CM, ungrammatical examples were created by cross-splicing, as described above—two ungrammatical examples for each verb. We divided the stimuli into two lists, lists A and B, where each list contained one grammatical and one ungrammatical example from each verb (except that there were no ungrammatical examples for verbs that have no CM). Each list thus contained 120 examples. These lists are given in Appendices E and F, respectively. Items in each list were randomized, and no subject was presented with more than one list.

4.2. Method. Experiment 2 was carried out after experiment 1, with the same subjects, under the same conditions. Subjects were instructed a second time and were provided with the grammatical example *čxindur d-opx^w* 'puts on a sock, stocking' and the ungrammatical sequence **čxindur y-opx^w*. They were told that for each word pair, they should push one button if the pair was correct in Batsbi, and to push the other button if it was not. Other methods and procedures were as for experiment 1.

4.3. Results and discussion. As in experiment 1, an initial pass through the data was used to identify those subjects who did not seem to be able to make the required linguistic judgment. Ten of the forty listeners were eliminated from the analyses for this reason, leaving thirty usable data sets.

Does marking a verb affect the processing difficulty of judging agreement? The lexical-decision results in experiment 1 demonstrated that it takes listeners extra processing time to recognize a verb that has a class marker compared to one that does not. The central question of experiment 2 is whether such markers can enhance the processing of syntactic agreement, given that this is precisely what the markers signal. Figure 3 presents the results of the explicit agreement task, for the comparison of words with no markers (0 CM) versus those with one marker (1 CM).

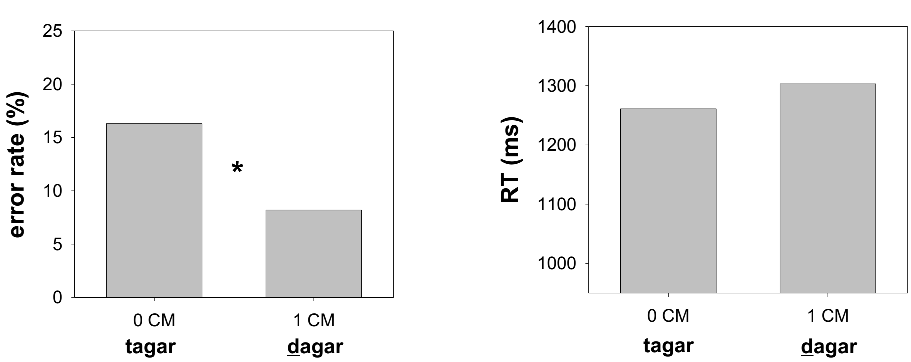

Figure 3. Error rates (left panel) and reaction times (right panel) for the syntactic-agreement task of experiment 2, for the comparison of words with 0 CM versus words with 1 CM.

As the figure illustrates, in this case, the answer to the question depends on whether one considers accuracy or speed. On the left side of the figure, the error results show an advantage for the verbs with an exponent: there were significantly fewer errors in judging agreement for verbs that had a class marker than for verbs that lacked one, $z = 3.301$, $p < 0.001$. This improvement in accuracy, however, came with some cost in processing time: the agreement judgments for verbs with one exponent took somewhat longer than judgments for ones with none, a nonsignificant 42 ms difference, $t = 1.364$. The results indicate that the extra work of processing the class marker was rewarded with improved evaluation of whether a noun agreed with the verb.

In a sense, the most interesting theoretical question is whether multiple marking of class is functional—why might exuberant agreement exist? This question is addressed in the comparison of agreement judgments for verbs with a single marker versus those that have two CMs. Figure 4 presents those results. As the figure shows, there is little or no evidence for the idea that multiple exponence is functional. Reaction times for the 2 CM stimuli were over a hundred milliseconds slower than those for 1 CM stimuli, a difference that did not quite reach significance, $t = 1.844$. There was a small accuracy difference favoring the 2 CM case, but this difference was not close to significant, $z = 0.232$, n.s.

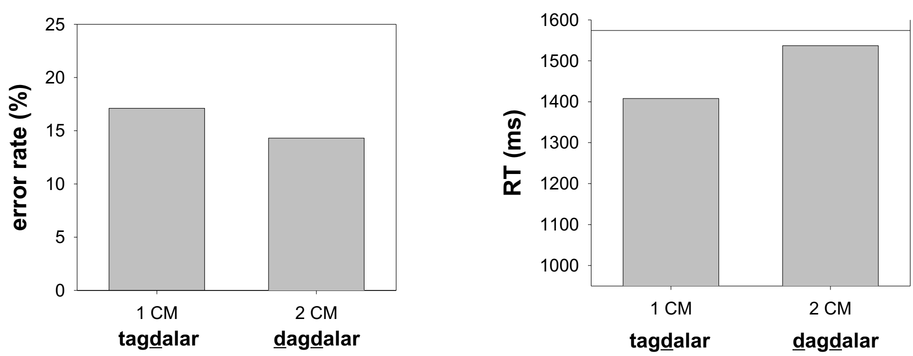

FIGURE 4. Error rates (left panel) and reaction times (right panel) for the syntactic-agreement task of experiment 2, for the comparison of words with 1 CM versus words with 2 CMs.

Collectively, the results of experiment 2 indicate that processing class markers requires extra cognitive effort; both for the 0 CM versus 1 CM comparison, and for the 1 CM versus 2 CM comparison, listeners were generally slower to recognize the agreement between a noun and verb when the verb carried more markers. For verbs with no marker versus verbs with some marking, this extra cognitive effort yielded improved accuracy—class marking helps to determine agreement. However, this advantage did not extend to exuberant agreement, as the extra processing time did not produce very much of an improvement in accuracy.

5. EXPERIMENT 3: DOES PROCESSING CLASS MARKERS AFFECT RECALL? In experiment 1, we tested whether the number of class markers would affect how difficult it was for listeners to recognize spoken words, and we found that there was in fact a processing cost for words with more markers. In experiment 2, we also found a processing time cost for such verbs, though at least for the 0 CM versus 1 CM comparison this extra processing time produced an accuracy advantage. In the final experiment, we look for a similar consequence of extra cognitive processing: Will listeners have better recall of the noun that accompanied a given verb in experiment 2, if the presence of more class markers led to more cognitive effort on those items? There is a large literature on memory that shows that in general, items that receive more cognitive processing will be remembered better (e.g. Craik & Tulving 1975). If processing class markers does involve this sort of cognitive effort, then it could lead to better recall.

5.1. MATERIALS. The verbal portions of the test items in experiment 2 were also used in experiment 3; that is, verbs were played without the accompanying noun.

5.2. METHOD. Subjects were auditorily presented with the verb forms from each grammatical test item that they had heard in experiment 2 and were asked to remember the noun that had accompanied it; the sixty-eight verbs were presented in a different random order for each subject. If the prior processing of a CM aids memory, subjects would be expected to have more correct responses from test items containing verbs with one CM than from examples containing verbs with no CM. If processing multiple CMs strengthens the memory representation more than processing a single CM, we should find more correct responses from test items containing multiple CMs.

Experiment 3 was carried out after experiment 2, with the same subjects, under the same conditions. Subjects were instructed again and as an example were provided with the grammatical example from experiment 2, *d-opx*^{w} 'puts on'. They were told to say both the noun that occurred with it and the verb—in this example, *čxindur d-opx*^{w} 'puts on a sock, stocking'. Their answers were recorded on a Roland Edirol R-09 digital recorder. In addition, the experimenter, also listening through headphones to the stimuli, wrote the responses phonetically.

5.3. RESULTS AND DISCUSSION. All subjects found this test difficult and some were unable to complete it. Some seemed to make up a subject or object that would be appropriate from the point of view of semantic and grammatical matching. We identified twenty-seven subjects who appeared to be able to do what we asked them to do.

The responses were scored in terms of whether the noun that the subject provided was in fact the one that had been presented with the probed verb. Figure 5 presents the average correct recall in this cued-recall task. Note that in this figure, unlike the other figures, higher values represent better performance. The left panel shows the comparison between verbs with no markers and matched verbs with a single CM. The result is clear: words with 1 CM produced twice as much recall as words without a CM, $z = 5.752$, $p < 0.001$. Note that in experiment 2, these same stimuli showed a comparable pattern: the pairs with 1 CM verbs took longer to respond to, but yielded more accurate performance. The results for the comparison of 2 CM verbs to 1 CM verbs are less clear. As the right side of Fig. 5 shows, there was actually a slight disadvantage for the 2 CM verbs, $z = -2.276$, $p < 0.03$. In experiment 2, there had been no significant difference between the 2 CM and 1 CM items on the accuracy measure, even though listeners had taken more time to process the 2 CM items.

Thus, the stimuli that themselves provide a clue (in the form of a gender-number marker) about the subject or object produced a higher accuracy of recall—one CM was better than none. Verbs with two CMs, however, were not recalled more accurately than those with one. The recall data of experiment 3 converge with the results of experiment 2 in casting doubt on the functionality of multiple class markers: they did not improve accuracy of agreement judgments, and they did not improve later recall (in fact, the difference was in the other direction).

The results of experiment 3 are consistent with the findings from the memory literature in that the items that had received more cognitive processing initially were better recalled later. In both experiments 2 and 3, however, the presence of exuberant agreement did not help—it generally seemed to require extra cognitive processing, but without providing much utility. This pattern suggests that exuberant agreement is not included in the language because of any advantage it might confer, but may instead be some kind of historical artifact.

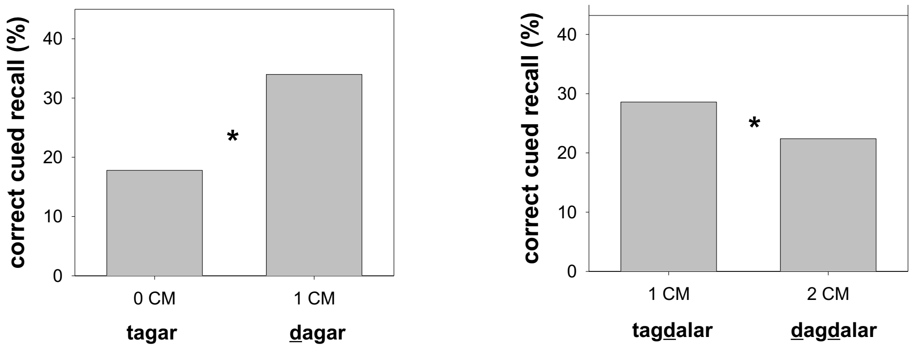

FIGURE 5. Correct cued recall percentage for words with 0 CM versus words with 1 CM (left panel), and correct cued recall percentage for words with 1 CM versus words with 2 CMs (right panel) in experiment 3.

6. GENERAL DISCUSSION. The main question this research addresses is whether multiple exponence provides any advantage in processing speech—does this seemingly inefficient system help listeners, providing some functionality? Across three experiments, we found little evidence for this, with more evidence to suggest that multiple exponence actually entails some disadvantage in processing Batsbi. Our experiments distinguished between verbs with two markers of agreement, verbs with one such marker, and verbs with no marker; we applied lexical-decision, grammaticality-judgment, and memory tasks. Relative to no agreement, a single agreement marker is disadvantageous with respect to response time on both lexical-decision and grammaticality-judgment tasks, but with the compensatory advantage of greater accuracy on the grammaticality-judgment and cued-recall tasks. If this effect is general (if it extends beyond this language), it is not surprising that languages might trade off somewhat longer response times in exchange for the advantage of greater accuracy. When we compared one agreement marker with two, we found that multiple exponence conferred a disadvantage (in response time for the grammaticality-judgment task, in both response time and accuracy for lexical decision, and in accuracy for cued recall). The results are thus consistent with the view that multiple exponence is relatively uncommon among languages of the world because it confers no advantage, or even a disadvantage, in language processing. (We note that ease of acquisition, another explanation that has been offered in connection with rarity, has not been tested for this particular phenomenon.) If multiple exponence confers no processing advantage, why would a language have it, and why would it continue in the language for a long period? One possibility remains that multiple exponence and other rare phenomena are the result of historical accident (Harris 2008b). It has been observed that many rare phenomena, such as exuberant exponence, are very complex and therefore require the coinciding of many changes or conditions. Probability tells us that these will coincide only infrequently, and consequently such phenomena will rarely be established.

Although these experiments were not designed to address the mode of processing (morphological parsing vs. direct recall) of complex words, the results have some relevance there as well. Processing of complex words in languages with rich morphologies has been little studied, with the exception of Finnish and Hebrew. Bertram, Laine, and Karvinen (1999) show that in Finnish speed of processing may depend on a distinction between derivational and inflectional morphology, morpheme productivity, and other factors. It has been shown that in languages with relatively poor morphology, such as English and Dutch (Bertram et al. 2000 on Dutch, and others), either inflectional morphology or productive morphology (among other factors) may trigger a parsing approach to word processing, rather than direct access. These and other studies make it clear that with increased productivity of affixes, processing costs increase (for example, Baayen et al. 2007, Plag & Baayen 2009). Because the inflectional morphemes studied in these Batsbi experiments may be assumed to be productive (see n. 3), our findings are consistent with the view that the same is true in other languages with rich morphology.

As the current experiments demonstrate, it can sometimes be useful to give up a bit of experimental control in exchange for the testing environment that is provided by languages with unusual properties. Clearly, the majority of research will focus on widely used languages, with readily accessible subject populations. Nonetheless, it will be important to examine less accessible populations in order to fully understand the range of language phenomena that comprise human language.

APPENDIX A: STIMULI FOR EXPERIMENT 1, SET A: VERB WITH 1 CM COMPARED WITH A VERB HAVING THE SAME ROOT

WITH CM		FREQ	ABLAUT	NUMBER SUPPL	NONWORD	WITHOUT CM		FREQ	ABLAUT	NUMBER SUPPL	NONWORD
d-ak’ar	‘burn (intr. active)’	3			*dap’ar	ak’ar	‘burn (intr. stative)’	4	y		*ap’ar
d-aɬar	‘give; appear’	5	y		*taɬar	aɬar	‘say’	5	y		*eɬar
d-aɬitar	‘cause to give’	5			*saɬitar	aɬitar	‘cause to say’	3			*eɬitar
d-at’ar	‘run away, flee; split’	5		y	*dut’ar	at’ar	‘become quiet’	5			*ut’ar
d-aq’ar	‘eat; be annoying’	5	y	y	*maq’ar	aq’ar	‘divide’	5	y		*uq’ar
d-axar	‘go; get drunk’	4.5	y		*duxar	axar	‘plow; bark’	5			*exar
d-axk’ar	‘come’	5		y	*duxk’ar	axk’ar	‘tie; dig’	5	y		*uxk’ar
d-aqar	‘take; suckle’	4	y		*diqar	aqar	‘pay, compensate’	4	y		*iqar
d-aħar	‘take; bring; castrate’	5	y		*doħar	aħar	‘steal; grind’	4	y		*oħar
d-eblar	‘place; lay; put down in’	5	y		*doblar	eblar	‘thread, put’	3	y	y	*oblar
d-ebc’ar	‘tie’	4	y		*dobc’ar	ebc’ar	‘push; weigh; milk’	5	y		*obc’ar
d-et:ar	‘fling; milk; pour’	5	y		*net:ar	et:ar	‘stand, stay’	5	y		*at:ar
d-et’-d-ar	‘take across; go mad’	3	y		*dep’dar	et’-d-ar	‘rip, split, tear’	4	y		*ep’dar
d-ešar	‘intend, promise’	4			*došar	ešar	‘lack, be missing’	3			*ošar
d-ot:ar	‘pour into’	5	y		*dut:ar	ot:ar	‘stand, stay’	4	y		*ut:ar
d-ol:ar	‘put; disgrace; lock’	5	y	y	*sal:ar	ol:ar	‘thread; put on; ladle’	5	y	y	*al:ar
d-ot’ar	‘go; go over’	4.5	y		*dop’ar	ot’ar	‘spread’	5	y		*op’ar
d-oc’-d-alar	‘be tied; follow’	3.5			*sac’dalar	oc’-d-alar	‘pull; weigh’	3	y		*ac’dalar
d-oc’ar	‘tie; enclose’	4			*dac’ar	oc’ar	‘pull, move; weigh’	5	y		*ac’ar
		4.4	12	4				4.3	15	2	

Some meanings have been simplified because of space considerations.

Appendix B: Stimuli for experiment 1, set B: verb with 1 CM compared with verb with no CM but with stem of similar structure

WITH CM		FREQ	ABLAUT	NUMBER SUPPL	NONWORD	WITHOUT CM		FREQ	ABLAUT	NUMBER SUPPL	NONWORD
d-agar	‘see, catch sight of’	4	y		*pagar	tagar	‘suit someone (e.g. clothing)’	3	y		*kagar
d-aržar	‘dissolve’	3			*garžar	tarsar	‘neigh’	2	y		*šarsar
d-ašar	‘melt’	3			*pešar	tasar	‘throw down, leave’	2	y		*kasar
d-exk’ar	‘arrange; sell; tie’	4	y		*mexk’ar	texk’ar	‘strew; name’	5	y		*nexk’ar
d-eqar	‘pay off, repay’	3	y		*keqar	teqar	‘crawl, creep; skim off’	3.5	y		*neqar
d-il:ar	‘lay; punish’	4	y		*t’al:ar	qol:ar	‘cover, clothe; benefit’	5	y		*kil:ar
d-išar	‘lie, be in bed’	5			*lišar	tišar	‘precipitate (from liquid)’	3.5			*tušar
d-ixk’ar	‘put, arrange, stack’	5	y	y	*nixk’ar	tixk’ar	‘name, give a name to’	3	y	y	*mixk’ar
d-oxar	‘fall apart; wear out’	3	y		*loxar	toxar	‘hit; play (instrument)’	2.5	y		*p’oxar
d-opxar	‘put on (clothing)’	5	y		*kopxar	labc’ar	‘play’	4			*kabc’ar
d-ivar	‘plant; be planted’	5			*pivar	lavar	‘speak out; survive’	4.5	y		*šavar
d-epsar	‘blow, puff up’	2	y		*nepsar	lapsar	‘dry out’	3	y		*mapsar
d-aʔar	‘come, arrive; bring’	5	y	y	*kaʔar	xaʔar	‘sit down; realize’	5	y	y	*p’aʔar
d-elar	‘laugh’	1.5			*melar	lelar	‘walk, move’	4.5			*selar
d-eč’ar	‘card, comb (wool)’	4			*teč’ar	leč’ar	‘peel’	3.5	y		*reč’ar
d-ołar	‘climb/squeeze in’	3.5	y		*tołar	xiłar	‘be, exist, become’	5	y		*šiłar
d-eq’ar	‘divide’	4	y		*geq’ar	meq’ar	‘remain, be left’	3	y		*zeq’ar
d-alar	‘die’	5			*talar	xalar	‘go out, be extinguished’	5	y		*šalar
d-ebžar	‘fall down; insert’	4.5	y		*gebžar	xabžar	‘sit down’	5	y	y	*šebžar
d-itar	‘cause to do/make’	5			*gitar	qetar	‘understand, know, guess’	5			*č’etar
d-op’t’ar	‘swallow’	5	y		*gop’t’ar	xep’t’ar	‘drink up, absorb’	5	y		*č’ept’ar
d-erc’ar	‘spin, turn back’	4	y		*gerc’ar	qerc’ar	‘toast, roast’	3.5	y		*xerc’ar
d-ast’ar	‘untie; rescue, save’	4.5			*nast’ar	qest’ar	‘travel around; mate’	3.5	y		*test’ar
d-ekar	‘call, cry out, shout’	5	y		*dokar	qekar	‘call out’	4			*xekar
		4.0	15	2				3.9	19	3	

Appendix C: Stimuli for experiment 1, set C: verb with 2 CMs compared with verb with 1 CM and a stem of similar structure

with 2 CMs		freq	ablaut	number suppl	nonword	with 1 CM		freq	ablaut	number suppl	nonword
d-ag-d-alar	'show oneself, be seen'	4			*dabdalar	tag-d-alar	'be done, made'	5	y		*pagdalar
d-opx-d-alar	'heat up; dress'	5	y		*gopxdalar	teps-d-alar	'fall (down)'	2	y		*kepsdalar
d-arž-d-alar	'dissolve'	4			*garždalar	xerc-d-alar	'change'	4	y		*šercdalar
d-os:-d-alar	'come down'	2			*tos:dalar	kot:-d-alar	'get upset'	4			*tot:dalar
d-it:-d-alar	'bathe'	5			*tit:dalar	qot:-d-alar	'open (leaves)'	4			*pot:dalar
d-ak'-d-ar	'burn, burn down/up'	4.5	y		*sak'dar	kak'-d-ar	'stir; dirty; chop'	5	y		*pak'dar
d-el-d-ar	'make laugh'	4			*seldar	zor-d-ar	'make brave/bold'	3.5			*sordar
d-os:-d-ar	'seat, set down'	2			*mos:dar	tat:-d-ar	'move (something) toward'	4.5	y		*gat:dar
d-ax:-d-ar	'drown; lengthen'	5			*max:dar	kot:-d-ar	'taper; oppress'	4.5			*pot:dar
d-aq-d-ar	'raise; exaggerate'	3.5			*gaqdar	teq-d-ar	'drag, trail'	4.5	y		*peqdar
d-ex-d-ar	'demolish; wear out'	5	y		*nexdar	lax-d-ar	'lower'	4.5			*taxdar
d-aš-d-ar	'melt; soak'	4			*nakdar	lak-d-ar	'throw, toss'	3.5		y	*nekdar
d-ek-d-ar	'cause to cry, plead'	5			*tašdar	teš-d-ar	'convince; confide'	3.5			*zesdar
d-ebl-d-ar	'begin, start'	4	y		*nebldar	tepl-d-ar	'avert; send off'	3.5	y		*kepldar
d-ol-d-ar	'begin, start'	4	y		*noldar	qol:-d-ar	'prop up, support'	3.5	y		*kiɬdar
d-ac'-d-ar	'burden, add weight'	4.5			*gac'dar	lac'-d-ar	'hurt'	4.5			*loc'dar
d-ec'-d-ar	'cause to love'	3.5			*γec'dar	tec'-d-ar	'teach, show, edify'	4			*kec'dar
d-uc'-d-ar	'fill (up), saturate'	4.5			*luc'dar	xac'-d-ar	'let know'	4.5			*xuc'dar
d-uq'-d-ar	'stop up; thicken'	4.5	y		*zuq'dar	toq'-d-ar	'enjoy'	5			*doq'dar
d-abc'-d-ar	'introduce'	3.5	y		*tabc'dar	labc'-d-ar	'play'	4	y		*zabc'dar
d-et'-d-ar	'transport; drive mad'	4	y		*met'dar	kat'-d-ar	'complain about'	3.5			*pat'dar
d-ic-d-ar	'forget'	5			*nicdar	lac-d-ar	'hold; arrest; rent'	5	y		*nacdar
d-axk'-d-ar	'(let) rot; drive in'	4		y	*gaxk'dar	qexk'-d-ar	'hang; boil'	5	y	y	*zexk'dar
d-epš-d-ar	'crumble'	3	y		*dopčdar	seps-d-ar	'cause to rise'	3	y		*šepsdar
d-ops-d-ar	'inflate'	3	y		*šapsdar	saps-d-ar	'cause to rise'	3	y		*sabždar
d-av-d-ar	'lose; slaughter; ease'	4.5		y	*mavdar	sab-d-ar	'sacrifice'	3.5			*labdar
d-oʔ-d-ar	'lead, bring (to)'	3			*noʔdar	quʔ-d-ar	'preserve; pamper'	3.5			*zuʔdar
d-erc'-d-ar	'turn; return'	3.5			*lerc'dar	ħerc'-d-ar	'turn'	4			*γerc'dar
		4.0	10	2				4.0	13	2	

Appendix D: Additional pseudowords used in experiment 1

*dazar, *dazdar, *daltar, *duldalar, *dałzar, *dapdar, *dint’ar, *dint’dalar, *daqsar, *dačdar, *dubcar, *debcdalar, *degar, *degdar, *dełar, *dusdalar, *dergar, *dordar, *decar, *dunardar, *diblar, *dibldar, *digar, *digdar, *dizar, *dizdar, *dižar, *dist’dalar, *dixar, *diqdar, *dunar, *dundar, *dogar, *dogdalar, *dozar, *dozdar, *domar, *domdalar, *dost’ar, *dost’dar, *dubnar, *dubdar, *dut’:ar, *dut:dalar, *durar, *duldar, *dupxar, *dupxdalar, *duč’ar, *duč’dar

Appendix E: Stimuli for experiment 2, list A

Part 1: Comparing 1 CM with no CM

VERBS WITH 1 CM		CROSS-SPLICED	VERBS WITH 0 CM	
k’nat **v**at’i^n	‘the boy ran away’	*k’nat **y**at’i^n	k’nat at’i^n	‘the boy got quiet’
ditx **d**aq’o	‘eats the meat’	*ditx **y**aq’ŏ	žabŏ aq’ŏ	‘divides the cows’
že **d**arže^n	‘the sheep spread out’	*že **b**arže^n	do^n tarse^n	‘the horse neighed’
ko^n **y**ašer	‘the fat was melting’	*ko^n **d**ašer	pħu teši^n	‘the dog obeyed’
bališ **b**il:e^n	‘laid (down) the pillow’	*bališ **y**il:e^n	meq qal:in	‘ate the bread’
nabad **b**oxe^n	‘shepherd’s cloak wore out’	*nabad **d**oxe^n	dayir tepxor	‘was playing the tambourine’
xalat **y**epxor	‘put on a house dress’	*xalat **d**epxor	k’nati labc’ir	‘the boys were playing’
pħatuy **y**opse^n	‘the lungs inflated’	*pħatuy **d**opse^n	dopxuin lapsi^n	‘the clothing dried’
yet: **b**axitie^n	‘let the cow go’	*yet: **d**axitie^n	yet: laxitie^n	‘made [them] look for the cow’
k’ec **y**ałi^n	‘gave [someone] the pan’	*k’ec **d**ałi^n	xi małe^n	‘drank the water’
kotam **d**uyłŏ	‘the chicken squeezes in’	*kotam **b**uyłŏ	ʕuv xiłe^n	‘became a shepherd’
želere^n **d**ali^n	‘the sheep died’	*želere^n **b**ali^n	santel xale^n	‘the candle went out (was extinguished)’
pst’arč **d**ebžor	‘was tying the oxen (e.g. in a yoke)’	*pst’arč **b**ebžor	kotmi xebžur	‘chickens were nesting’
pst’uinŏ xak’**y**ie^n	‘made the woman thirsty’	*pst’uinŏ xak’**v**ie^n	xi xop’t’i^n	‘absorbed the water’
st’ak’ **v**erc’i^n	‘the man turned’	*st’ak’ **y**erc’i^n	c’ebl qarc’i^n	‘roasted the chestnut(s)’
vir **d**ast’i^n	‘untied the donkey’	*vir **b**ast’i^n	pst’i qast’e^n	‘the women walked around’

Part 2: Comparing 2 CMs with 1 CM

VERBS WITH 2 CMs		CROSS-SPLICED	VERBS WITH 1 CM		CROSS-SPLICED
xi **d**opx**d**ie^n	‘heated the water’	*xi **y**opx**y**ie^n	xi maxk’**d**ali^n	‘the water spilled’	*xi maxk’**y**ali^n
yoħ **y**os:**y**ali^n	‘the girl came down involuntarily’	*yoħ **v**os:**v**ali^n	pst’uinŏ kot:**y**ali^n	‘the woman got upset’	*pst’uinŏ kot:**v**ali^n
qori **d**ek’**d**ie^n	‘threw down apples’	*qori **y**ek’**y**ie^n	šakar kak’**d**ie^n	‘stirred in the sugar’	*šakar kak’**y**ie^n
yoħ **y**el**y**or	‘made the girl laugh’	*yoħ **v**el**v**or	pst’uinŏ zor**y**or	‘emboldened the woman’	*pst’uinŏ zor**v**or
k’nat **v**os:**v**ie^n	‘set down the boy’	*k’nat **y**os:**y**ie^n	meq tat:**b**ie^n	‘moved the bed’	*meq tat:**d**ie^n
c’eril **d**ax:**d**ie^n	‘lengthened the letter’	*c’eril **b**ax:**b**ie^n	pst’ui kot:**d**ie^n	‘upset the women’	*pst’ui kot:**b**ie^n
xi **d**epx**d**or	‘was heating up the water’	*xi **b**epx**b**or	že tepl**d**ie^n	‘sent the sheep out’	*že tepl**b**ie^n
be^n **b**ox**b**ie^n	‘tore down the nest’	*be^n **d**ox**d**ie^n	satar teq**y**ie^n	‘dragged the thing-to-be-dragged’	*satar teq**b**ie^n
kok’duypx **d**ex**d**or	‘wore out the shoes’	*kok’duypx **y**ex**y**or	ko laq**d**ie^n	‘stretched out a hand’	*ko laq**y**ie^n
moq **b**ek**b**ie^n	‘had someone call the song’	*moq **d**ek**d**ie^n	st’ak’ teš**v**ie^n	‘convinced the man’	*st’ak’ teš**d**ie^n
mač’ar **d**as**d**ie^n	‘poured out the wine’	*mač’ar **y**as**y**ie^n	qer lak**b**ie^n	‘threw the rock’	*qer lak**y**ie^n
lav **d**aš**d**ie^n	‘melted the snow’	*lav **y**aš**y**ie^n	pst’arč kes**d**ie^n	‘made the oxen work’	*pst’arč kes**b**ie^n
čxindur **d**ol**d**ie^n	‘started a sock, stocking’	*čxindur **y**ol**y**ie^n	c’inus tił**y**ie^n	‘sent off the bride’	*c’inus tił**d**ie^n

bʕak’a^{n} **y**ac’**y**ie^{n}	‘made the bag used in making cheese’	*bʕak’a^{n} **d**ac’**d**ie^{n}	ħak’ lac’**d**ie^{n}	‘hurt [his/her] shoulder’	*ħak’ lac’**b**ie^{n}
k’nat **v**ec’**v**ie^{n}	‘made [someone] love the boy’	*k’nat **y**ec’**y**ie^{n}	ambuy xac’**y**ie^{n}	‘let [them] know the news’	*ambuy xac’**b**ie^{n}
botl **y**uc’**y**ie^{n}	‘filled the bottle’	*botl **d**uc’**d**ie^{n}	k’ab qoc’**y**ie^{n}	‘hung the dress’	*k’ab qoc’**b**ie^{n}
čwix **d**ot’**d**ie^{n}	‘carried the lamb across’	*čwix **b**ot’**b**ie^{n}	xi lat’**d**ie^{n}	‘added the water’	*xi lat’**y**ie^{n}
as: **d**ic**d**ie^{n}	‘forgot the calf’	*as: **b**ic**b**ie^{n}	ča lac**b**ie^{n}	‘caught the bear’	*ča lac**d**ie^{n}

Nouns are ambiguously definite or indefinite but are translated here as definite (‘the’) whenever possible. Transitive sentences here have no subject expressed; this can be interpreted as third-person singular or third-person plural, but it is not translated here.

Appendix F: Stimuli for experiment 2, list B

Part 1: Comparing 1 CM with no CM

VERBS WITH 1 CM		CROSS-SPLICED	VERBS WITH 0 CM	
yoħ **y**at’i^{n}	‘the girl ran away’	*yoħ **v**at’i ^{n}	yoħ at’i ^{n}	‘the girl got quiet’
meq **y**aq’o	‘eats the bread’	*meq **d**aq’ŏ	že aq’ŏ	‘divides the sheep’
žabŏ **b**arže^{n}	‘the cows spread out’	*žabŏ **d**arže^{n}	baq’ŏ tarse^{n}	‘the colt neighed’
lav **d**ašer	‘the snow was melting’	*lav **y**ašer	bader teši^{n}	‘the child obeyed’
gaga^{n} **y**il:e^{n}	‘laid an egg’	*gaga^{n} **b**il:e^{n}	ditx qal:in	‘ate the meat’
kok’duypx **d**oxe^{n}	‘the shoes wore out’	*kok’duypx **b**oxe^{n}	buzk’ant’ tepxor	‘was playing the harmonica’
kok’duypx **d**epxor	‘put on the shoes’	*kok’duypx **y**epxor	maxk’ar labc’ir	‘the girls were playing’
t’ik’čor **d**opse^{n}	‘the wineskin inflated’	*t’ik’čor **y**opse^{n}	naq’iš lapsi^{n}	‘the streets dried’
želere^{n} **d**axitie^{n}	‘let the sheep (SG) go’	*želere **b**axitie^{n}	že laxitie^{n}	‘made [them] look for the sheep’
herc’ŏ **d**aɬi^{n}	‘gave [someone] the pot’	*herc’ŏ **y**aɬi^{n}	mačar maɬe^{n}	‘drank the wine’
pħu **b**uyɬŏ	‘the dog squeezes in’	*pħu **d**uyɬŏ	ag xiɬe^{n}	‘became a grandmother’
do^{n} **b**ali^{n}	‘the horse died’	*do^{n} **d**ali^{n}	c’e xale^{n}	‘the fire went out’
pst’u **b**ebžor	‘was tying the ox (e.g. in a yoke)’	*pst’u **d**ebžor	ħayc’k’i xebžur	‘birds were nesting’
st’ak’ xak’**v**ie^{n}	‘made the man thirsty’	*st’ak’ xak’**y**ie^{n}	q’ar xop’t’i^{n}	‘absorbed the rain’
pst’uinŏ **y**erc’**i**^{n}	‘the woman turned’	*pst’uinŏ **v**erc’**i**^{n}	xorbal qarc’i^{n}	‘roasted the wheat’
yet: **b**ast’i^{n}	‘untied the cow’	*yet: **d**ast’i^{n}	vaser qast’e^{n}	‘the men walked around’

Part 2: Comparing 2 CMs with 1 CM

VERBS WITH 2 CMs		CROSS-SPLICED	VERBS WITH 1 CM		CROSS-SPLICED
šur **y**opx**y**ie^{n}	‘heated the milk’	*šur **d**opx**d**ie^{n}	šur maxk’**y**ali^{n}	‘the milk spilled’	*šur maxk’**d**ali^{n}
k’nat **v**os:**v**ali^{n}	‘the boy came down involuntarily’	*k’nat **y**os:**y**ali^{n}	st’ak’ kot:**v**ali^{n}	‘the man got upset’	*st’ak’ kot:**y**ali^{n}
tut **y**ek’**y**ie^{n}	‘threw down mulberry/ies’	*tut **d**ek’**d**ie^{n}	šur kak’**y**ie^{n}	‘stirred in the milk’	*šur kak’**d**ie^{n}
k’nat **v**el**v**or	‘made the boy laugh’	*k’nat **y**el**y**or	st’ak’ zor**v**or	‘emboldened the man’	*st’ak’ zor**y**or
yoħ **y**os:**y**ie^{n}	‘set down the girl’	*yoħ **v**os:**v**ie^{n}	čak’ŏ tat:**d**ie^{n}	‘moved the chair’	*čak’ŏ tat:**b**ie^{n}
moq **b**ax:**b**ie^{n}	‘lengthened the poem’	*moq **d**ax:**d**ie^{n}	vaser kot:**b**ie^{n}	‘upset the men’	*vaser kot:**d**ie^{n}
meždar **b**epx**b**or	‘was heating up the cornbread’	*meždar **d**epx**d**or	žabŏ tepl**b**ie^{n}	‘sent the cows out’	*žabŏ tepl**d**ie^{n}
c’a **d**ox**d**ie^{n}	‘tore down the house’	*c’a **b**ox**b**ie^{n}	nabad teq**b**ie^{n}	‘dragged the cloak’	*nabad teq**y**ie^{n}
k’ab **y**ex**y**or	‘wore out the dress’	*k’ab **d**ex**d**or	top laq**y**ie^{n}	‘stretched out a gun’	*top laq**d**ie^{n}
bader **d**ek**d**ie^{n}	‘had someone call the child’	*bader **b**ek**b**ie^{n}	bader teš**d**ie^{n}	‘convinced the child’	*bader teš**v**ie^{n}
šur **y**as**y**ie^{n}	‘poured out the milk’	*šur **d**as**d**ie^{n}	γoč’ lak**y**ie^{n}	‘threw the rock’	*γoč’ lak**b**ie^{n}

ko^{n} **y**aš**y**ie^{n}	‘melted the fat’	*ko^{n} **d**aš**d**ie^{n}	pst’u kes**b**ie^{n}	‘made the ox work’	*pst’u kes**d**ie^{n}
k’ab **y**ol**y**ie^{n}	‘started a dress’	*k’ab **d**ol**d**ie^{n}	bader tiɬ**d**ie^{n}	‘sent off the child’	*bader tiɬ**y**ie^{n}
telzi **d**ac’**d**ie^{n}	‘made the saddlebags heavy’	*telzi **y**ac’**y**ie^{n}	kortǒ lac’**b**ie^{n}	‘hurt [his/her] head’	*kortǒ lac’**d**ie^{n}
yoħ **y**ec’**y**ie^{n}	‘made [someone] love the girl’	*yoħ **v**ec’**v**ie^{n}	p’asux xac’**b**ie^{n}	‘let [them] know the answer’	*p’asux xac’**y**ie^{n}
durk’ **d**uc’**d**ie^{n}	‘filled the cask’	*durk **y**uc’**y**ie^{n}	qaqa^{n} qoc’**b**ie^{n}	‘hung the skin’	*qaqa^{n} qoc’**y**ie^{n}
pħu **b**ot’**b**ie^{n}	‘carried the dog across’	*pħu **d**ot’**d**ie^{n}	šur lat’yie^{n}	‘added the milk’	*šur lat’**d**ie^{n}
yet: **b**ic**b**ie^{n}	‘forgot the cows’	*yet: **d**ic**d**ie^{n}	ħac’uk’ lac**d**ie^{n}	‘caught the bird’	*ħac’uk’ lac**b**ie^{n}

Appendix G: Camouflaged morphemes

In Batsbi, many lexemes have contrasting perfective/imperfective roots; the imperfective is used as the basis for the present and imperfect tenses and certain others, while the perfective is used as the basis for the future and aorist tenses and certain others. Although there are some regularities in these, it is not possible to predict the form of one from the other. Sometimes only vowel alternation is involved; for example, the imperfective masdar *d-et’-d-ar* ‘take across’ corresponds to the perfective masdar ***d**-ot’-**d**-ar* in the same meaning. It is common for perfectives with the root vowels *a*, *i*, or *o* to correspond to an imperfective in *e*, as in this example. There are a number of examples where a perfective with a preradical CM, as in the example *d-ek’ar* ‘fall, drop (PL)’/*ak’ar*, corresponds to an imperfective without that CM; but this is not a productive distinction. Forms that are only perfective or only imperfective contain a ‘camouflaged’ morpheme, and may arguably be more complex morphologically than a form like *at’-ar* ‘become quiet’, which has no perfective-imperfective contrast.

A few verbal lexemes have different roots according to the number of subjects or objects; for example, *qel:na is* ‘eat one thing’ is used when the object is singular, while ***d**-eq’na* ‘eat many things’ is used when the object is plural. The forms *ʕe-**d**-aγar* (imperfective) and *ʕa-**d**-aγar* (perfective) ‘sit’ are used when the subject is singular, and *ʕe-**d**-axk’ar* (imperfective), *ʕa-**d**-axk’ar* (perfective) ‘sit’ are used when the subject is plural.

In the stimuli for experiment 1, we have tried to balance the sets for these two variables, as described in the text.

REFERENCES

Baayen, R. Harald; Lee H. Wurm; and Joanna Aycock. 2007. Lexical dynamics for low-frequency complex words: A regression study across tasks and modalities. *The Mental Lexicon* 2.419–63.

Bertram, Raymond; Matti Laine; and Katja Karvinen. 1999. The interplay of word formation type, affixal homonymy, and productivity in lexical processing: Evidence from a morphologically rich language. *Journal of Psycholinguistic Research* 28.3.213–26.

Bertram, Raymond; Robert Schreuder; and R. Harald Baayen. 2000. The balance of storage and computation in morphological processing: The role of word formation type, affixal homonymy, and productivity. *The Journal of Experimental Psychology: Learning, Memory, and Cognition* 26.489–511.

Bowerman, Melissa. 1985. What shapes children’s grammars? *The crosslinguistic study of language acquisition, vol. 2: Theoretical issues*, ed. by Dan Isaac Slobin, 1257–319. Hillsdale, NJ: Lawrence Erlbaum.

Burani, Cristina, and Anna M. Thornton. 2003. The interplay of root, suffix and whole-word frequency in processing derived words. *Morphological structure in language processing*, ed. by R. Harald Baayen and Robert Schreuder, 158–207. Berlin: Mouton de Gruyter.

Craik, Fergus, and Endel Tulving. 1975. Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General* 104.268–94.

Feldman, Laurie Beth; Ram Frost; and Tamar Pnini. 1995. Decomposing words into their constituent morphemes: Evidence from English and Hebrew. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 21.947–60.

GREENBERG, JOSEPH H. 1978. Diachrony, synchrony, and language universals. *Universals of human language, vol. 1: Method and theory*, ed. by Joseph H. Greenberg, Charles A. Ferguson, and Edith A. Moravcsik, 61–91. Stanford, CA: Stanford University Press.

HARRIS, ALICE C. 2008a. On the explanation of typologically unusual structures. *Linguistic universals and language change*, ed. by Jeff Good, 54–76. Oxford: Oxford University Press.

HARRIS, ALICE C. 2008b. Explaining exuberant agreement. *Linguistic theory and grammatical change: The Rosendal papers*, ed. by Thórhallur Eythórsson, 265–83. Amsterdam: John Benjamins.

HARRIS, ALICE C. 2009. Exuberant exponence in Batsbi. *Natural Language and Linguistic Theory* 27.267–303.

HARRIS, ALICE C. 2010. Explaining typologically unusual structures: The role of probability. *Rethinking universals: How rarities affect linguistic theory* (Empirical approaches to linguistic typology 45), ed. by Jan Wohlgemuth and Michael Cysouw, 91–104. Berlin: De Gruyter Mouton.

HAWKINS, JOHN A., and ANNE CUTLER. 1988. Psycholinguistic factors in morphological asymmetry. *Explaining language universals*, ed. by John A. Hawkins, 280–317. Oxford: Blackwell.

JÄRVIKIVI, JUHANI; RAYMOND BERTRAM; and JUSSI NIEMI. 2006. Affixal salience and the processing of derivational morphology: The role of suffix allomorphy. *Language and Cognitive Processes* 21.4.394–431.

KADAGIӡE, DAVIT, and NIK'O KADAGIӡE. 1984. *C'ova-tušur-kartul-rusuli leksik'oni*. [Tsova-Tush-Georgian-Russian dictionary.] Tbilisi: Mecniereba.

KUČERA, HENRY, and W. NELSON FRANCIS. 1967. *Computational analysis of present-day American English*. Providence, RI: Brown University Press.

KUPERMAN, VICTOR; RAYMOND BERTRAM; and R. HARALD BAAYEN. 2010. Processing trade-offs in the reading of Dutch derived words. *Journal of Memory and Language* 62.83–97.

LAUDANNA, ALESSANDRO, and CRISTINA BURANI. 1995. Distributional properties of derivational affixes: Implications for processing. *Morphological aspects of language processing*, ed. by Laurie Beth Feldman, 345–64. Hillsdale, NJ: Lawrence Erlbaum.

NEWMEYER, FREDERICK J. 2005. *Possible and probable languages: A generative perspective on linguistic typology*. Oxford: Oxford University Press.

PLAG, INGO, and HARALD BAAYEN. 2009. Suffix ordering and morphological processing. *Language* 85.109–52.

Harris
Department of Linguistics
226 South College
150 Hicks Way
University of Massachusetts
Amherst, MA 01003
[acharris@linguist.umass.edu]
[a.samuel@bcbl.eu]

[Received 11 May 2010;
revision invited 16 September 2010;
revision received 5 February 2011;
accepted 15 February 2011]